# How Executive Compensation Changes In Response to Personal Income Tax Shocks

## (Who Pays the CEO's Income Taxes?)

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**Abstract**

Using staggered personal income tax changes across US states, we study the effects of taxes on executive compensation. After a tax rate increase, pay of CEOs increases within two years by more than the increased tax liability. The effect on pay is stronger in more profitable industries. The higher tax rate appears to motivate CEOs to sell firm stock for liquidity. Boards respond by increasing cash pay to replace liquidity and stock pay to replenish CEO incentives. The effect of personal income tax on compensation is asymmetric: CEOs do not experience pay cuts following tax cuts.

*Keywords*: Executive compensation, Personal income tax, CEO incentives, CEO equity sales

*JEL codes*: H24, H71, J33, M12

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### 1. Motivation and Hypotheses

The level and structure of executive pay are complex and controversial concerns. Persistent interest among investors, regulators, politicians, and executives has spawned a sizable scholarly literature that addresses the determinants, economic and otherwise, of the level and incentive properties of executive pay. Per Edmans, Gabaix, and Jenter (2017), in their survey of the theories and empirical evidence on managerial compensation, the various empirical designs arise from at least three, non-mutually-exclusive perspectives: shareholder value maximization; rent extraction by executives; and institutional forces, including taxation.

The focus in the literature has been on the first two perspectives.

> Most recent analyses of executive compensation have focused on efficient-contracting or managerial-power rationales for pay, while ignoring or downplaying the causes and consequences of disclosure requirements, **tax policies**, accounting rules, legislation, and the general political climate. (Murphy (2013), emphasis added)

We emphasize the third line of inquiry to assess the effects of tax policies on executive compensation. In particular, we investigate how exogenous changes in personal income tax rates affect the level, composition, and incentive properties of CEO compensation in listed US firms.

There are at least two reasons why a change in personal tax rate would affect the **level** of executive pay. First, higher income taxes can directly reduce executives' after-tax income, thereby potentially shifting the supply curve for executive input upward. If the demand curve for top executive talent is relatively inelastic, which likely is the case in a thin market for suppliers of high-level managerial input, then the firm will respond to a shift in the manager's supply curve

with meaningful additional pay, with the incidence of the tax falling on other stakeholders of the firm. Second, if an executive is entrenched or otherwise has the ability to extract rents from the firm, perhaps because the board of directors is co-opted (Coles, Daniel, and Naveen, 2014) or not truly independent (Weisbach, 1988), then the manager potentially can wrest higher pay to cover the increased tax liability. Either way, raising executive pay in response to a tax rate increase likely means paying at least some of the executive's tax bill with shareholder money. We expect the level of CEO pay to increase in response to a tax rate increase.

A change in income taxes should also affect the **composition**, in terms of the mix of cash, stock, and options, of both annual pay and the executive's portfolio of accumulated past awards net of dispositions.. The reasons include (a) executive incentive alignment and (b) the need of the taxpayer for cash as the means to satisfy their tax obligation. To illustrate the latter, the liquidity need, in 2012 California raised its maximum personal income tax rate (from 10.3% to 13.3% for annual income greater than $1M. Consider Mr. Lawrence J. Ellison, the CEO of Oracle, headquartered in California, with reported compensation of US$96.16M in 2012.[1] For simplicity, in the absence of a progressive state tax schedule, assuming no state and local tax (SALT) deduction at the federal level, and supposing that the figure is immediately taxable, the 3% increase in the state income tax rate would decrease his after-tax pay and increase his state and overall tax liability by US$ 2.88M.[2] More generally, in 2012 average CEO compensation in S&P 500 firms was $10.6M. Absent the SALT deduction, a 3% tax increase increases the average CEO's tax

[1] https://www.sec.gov/Archives/edgar/data/1341439/000119312512399999/d399484ddef14a.htm#toc399484_20.

[2] In 2012 the SALT deduction was not yet capped. The increase in tax for Mr. Ellison, assuming a 35% federal income tax rate, would have been $1.86M = $96.16M × 0.03 × [1-0.35]. As of 2018, the SALT deduction was capped at $10,000.

payment by $318K. This likely creates some preference on the part of executives for a larger proportion of compensation to be paid in cash so as to facilitate settlement of the increased tax bill.

This argument for an increased preference for cash requires frictions. To satisfy the increased state tax bill the executive could sell accumulated shares or options or exercise options to sell stock. But suppose stock or option markets are imperfect or, more likely, a sale or exercise and sale triggers tax on realized gains. In addition, sales of stock by a top executive require disclosure and can draw unwelcome attention to the executive and firm from investors, the media, and regulators. In the presence of such frictions, an increase in tax rate would strengthen the preference of the executive for cash as a component of compensation.

Note as well that for some time there has been a tax friction in place gravitating against the use of cash in executive pay. Starting in 1994 the US limited the deductibility of pay for top-five executives of public firms to $1 million per executive per year (IRS Section 162(m)), with incentive pay exempt from that limit[3], at which time firms shifted towards compensating top executives with stock and options (Perry and Zenner, 2001). This move away from awarding cash further obliges the executive to liquidate shares or options to cover a larger tax bill. Following a tax rate increase, we expect executives to sell equity.

In terms of (a) executive incentives, such sales of stock and options reduce the manager's firm-related wealth, dampen the sensitivity of CEO wealth to performance, and diminish the incentive of the executive to act in the interest of shareholders. We expect firms to replace those lost equity incentives with larger stock grants. In addition, the change in tax rate affects managerial incentive

[3] In 2018 (IRS iNotice 2018-68, arising from the Tax Cuts and Jobs Act of 2017), this exemption was eliminated and the scope of coverage of 162(m) was extended from the CEO to include CFOs and three other highest-paid employees,

alignment, even if the stock and option holdings of the manager remain unchanged. A standard measure of incentive alignment is delta, the sensitivity of CEO wealth to stock price arising from the accumulation of stock and options net of dispositions (Jensen and Murphy, 1990; Core and Guay, 2002). Higher delta can mean that managers will work harder or more effectively because managers share gains and losses with shareholders. If pre-tax delta is given by $\delta$, and the appropriate state and federal tax rates on stock grants as compensation are $\tau_s$ and $\tau_f$, then *after-tax delta* is $\delta_{AT} = (1 - \tau_s - \tau_f)\delta$. It likely is after-tax delta that matters for the incentives of the manager, so an increase in $\tau_s$ or $\tau_f$ requires an increase in pre-tax $\delta$, through additional awards of stock for example, to return post-tax $\delta_{AT}$ to the pre-tax-change level. In addition to replacing liquidated stock and options, returning post-tax incentives to the prior level requires further adjustment in the pre-tax effective CEO ownership of the firm.

We use staggered state-level personal income tax changes as plausibly exogenous shocks to tax rates and apply a difference-in-differences (DiD) approach. Compared with federal tax changes, state-level changes in personal income taxes happen more frequently and do not affect all states at the same time. The staggered nature of state-level personal tax shocks provides valid control firms as a set of counterfactuals for how executive compensation would have evolved without the tax changes. Over the period 1992 – 2018 there were 347 changes in the top state personal income tax rates, of which 109 (238) were increases (decreases). Following Heider and Ljungqvist (2015), we focus primarily, though not exclusively, on 38 large tax rate shocks (rate changes greater than 1%), including 22 tax increases and 16 tax cuts (see Fig. 1).

In our DiD analysis, the treated group includes CEOs of firms headquartered in states experiencing large increases or decreases in top personal income tax rates. Our control group includes the remaining CEOs in the sample. When there is a single shock involved, it is common

to define a treatment dummy that equals one after the shock. In this study, however, one state can experience repeated shocks. For example, one tax increase may be followed by another tax increase or decrease in the same state in future years. In this case, a single treatment dummy equal to one after the first shock would fail to capture the subsequent shocks. To address this issue, we follow Heider and Ljungqvist (2015) and use the first difference of *all* variables in our DiD analysis. Specifically, we define a dummy variable ,*Tax Increase* (*Decrease*), that equals one if a tax increase (decrease) larger than 1% occurs in the headquartered state in a year. This treatment variable indicates the appearance of every tax shock (increases or decreases) in a state and is equivalent to the first difference in a level treatment variable.

Our DiD estimates show that CEOs receive economically and statistically higher pay two years after an increase in personal income tax rates. Specifically, CEOs receive an 5.7% increase in pay following large tax increases relative to CEOs who do not experience such tax shocks, all else equal. In stark contrast, when income tax rates decrease, we observe no significant changes in total pay. The reaction of CEO compensation to tax increases versus decreases is asymmetric. The CEO responds to the state tax increase by liquidating a significant proportion of shares held. Firms respond by increasing both cash compensation and shares granted to the CEO. The extra increase in annual cash salary is 1.2% while the increase in equity pay is 12.6%, all else equal. Furthermore, the firm increases pre-tax CEO delta incentives by 2.4 % after a large tax rate increase. So in terms of timing, for a tax increase in year $t$ in one state, an affected CEO needs to pay the increased tax no later than April (or perhaps October) in year $t$+1, with few incentives to pay before that. In terms of covering the tax bill, income tax rate increases are associated with a large increase in CEO sales of personal holdings of their company stock in year $t$+1. Then boards respond by adjusting CEO compensation in the following year, year $t$+2.

To further quantify the tax effects, we regress the proportional change in managerial pay on the *net-of-tax ratio*, the ratio of pre-tax-change (year *t-r*) *net-of-tax rate* (*NOT*) to the post-tax-change (year *t*) net-of-tax rate: $(1 - \tau_{f,t-r} - \tau_{s,t-r})/(1 - \tau_{f,t} - \tau_{s,t})$.[4] An estimate of the coefficient on the net-of-tax ratio equal to 1 would indicate that the proportional change in executive pay exactly offsets the tax increase, making the executive whole after-tax and fully shifting the incidence of the tax increase to the firm. Our results suggest the response is even larger. When the *net-of-tax ratio* changes up or down by 1%, CEO pay changes by 1.251%. When focusing on tax rate increases, this elasticity increases to 1.987%. The elasticity of CEO pre-tax delta in the net-of-tax-rate is 2.345 for large tax increases. The firm more than fully restores post-tax pay level and pre-tax delta incentives.

Our analysis survives additional hurdles for credible identification. First, we investigate whether state tax changes arise from prior rapid growth in executive pay. They do not. Second, a potential concern is that both state tax changes and executive pay changes can be affected by local economic conditions, while our baseline setting includes control firms that are geographically not proximate to the corresponding treated firms. Exploiting the fact that local economic conditions tend to be similar in bordering states, we use a control group including only CEOs of firms headquartered in bordering states that do not experience any tax shock. This neighboring control group establishes the counterfactual response of CEO compensation to the unobserved local factors excluding the effects of tax changes. We confirm that the effect of tax changes on CEO

[4] This extends Frydman and Malloy (2011), who employ this ratio for federal taxes. The use of the net-of-tax rate comports with norms in the public economics literature,

pay is robust to the bordering-state setting. Third, we verify that the treated and control groups have parallel trends in CEO pay changes before both positive and negative shocks to tax rates.

We provide several other findings. First, named executive officers (NEOs) who are not the CEO receive a much smaller pay increase of about 2.5%, about half of that of the CEO, in response to an increase in personal income tax rate. Like CEO pay, NEO pay does not decline in response to a tax decrease. Second, when a CEO experiences a tax increase but the firm does not increase pay, the likelihood of CEO turnover is higher. Firms that fail to increase CEO pay after a tax increase have significantly lower subsequent stock and accounting (ROA) performance. Third, the responsiveness of CEO pay to tax increases is stronger in firms that operate in more profitable industries.

Our analysis contributes materially to three segments of the literature. First, we contribute new evidence to the research on the effect of taxes on executive compensation. For example, we build on the prior work of Frydman and Malloy (2011). Using a sample of top executives in 50 large firms from 1946 to 2005, they find very little response in pay of executives to changes in federal tax rates on labor income. Other previous studies on the topic report that changes in income tax rates have negligible effects on CEO compensation (Goolsbee, 2000; Hall and Liebman, 2000; Rose and Wolfram, 2002).. Our results differ substantially. One possible reason is that federal tax shocks apply to executives across all states, in which case the tax shock does not affect the change in relative after-tax opportunity wage obtainable by a CEO willing to move to another company with employees taxable in a different domicile. A federal tax increase does not make the grass relatively greener in another state. This difference in outside options, in contrast to staggered state tax rate changes, could lead to the minimal executive pay responses to federal tax

changes, even though federal tax changes are usually larger in size.[5] Other possible reasons for the differing results, aside from the use of staggered state tax shocks for identification, include different sampling of firms and executives, the use of different fixed effects, and whether the state tax rate is included in the net-of-tax rate.

Second, we contribute to the broader literature on incentive compensation and governance. We introduce and emphasize the difference between pre-tax and *after-tax delta* for managerial incentive alignment. In addition, our findings support the idea (Murphy, 2013) that boards prioritize executive incentive alignment and managerial retention over the financial and political costs of higher executive compensation. Nonetheless, CEO pay is insensitive downward to tax decreases, which suggests that CEO entrenchment and bargaining position have some power to explain pay. Third, our evidence has policy implications. For example, there are recent calls at the state and federal level to increase the progressivity of the income tax. Our analysis highlights the fact that whether this would reduce the inequalities in earnings between top executives and the median worker depends on the elasticity of firm demand for each type of employee and on bargaining power. Such factors will determine the success of various initiatives, including California Senate Bill 37, which would impose significant taxes on firms that have the largest gaps between the highest-earning and lowest-paid employees.[6]

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[5] On the other hand, it appears that top executives are attuned to differences in state tax rates and will relocate in response. While the SARS-2 pandemic is a consideration, tax differentials on their own are a significant factor (https://www.bizjournals.com/sanfrancisco/news/2020/11/17/california-exodus-roared-on-even-before-covid-hit.html). Elon Musk, the CEO of Tesla, recently announced he moved his residence from California to Texas (https://www.bbc.com/news/technology-55246148). Hewlett Packard Enterprises announced plans to relocate its headquarters from San Jose to Houston (https://www.cnn.com/2020/12/13/tech/silicon-valley-moving-to-austin-miami/index.html). California has high personal income tax rates, while Texas has no personal income tax.

[6] California SB 37, the "Corporate Fair Share for California and Californians," originally proposed that large corporations that do business in California would face a tax increase of 2% to 6%, depending on the difference between what the CEO is paid and the pay of their average worker (https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200SB37). As of January 2020, an

## 2. Empirical Design

Our empirical analysis is based on staggered changes in top personal income tax rates at the state levels. As CEOs usually have very high income, we assume that the top personal income tax rates apply to them. We use a DiD approach and study the changes in CEO pay in response to changes in top personal income tax rates. Following Heider and Ljungqvist (2015), our main analysis focuses on the large tax changes that are greater than 1%. In the DiD analysis, treated firms are those headquartered in states experiencing large tax shocks (increase or decrease), while control firms are those headquartered in states without tax shocks.

In a DiD analysis based a single event, the treatment variable is usually set to one in years after the event (as illustrated in the upper panel of Appendix Figure IA2). In our analysis, however, there are multiple shocks to tax rates along time and there can be repeated shocks in one state. Therefore, it would not be appropriate to simply keep the treatment variable as one in years after an event because a following (repeated) shock would not be captured in this way (lower panel of Appendix Figure IA2). One way to accommodate repeated events is to set the treatment variable as a count variable, or equivalently, use the first differences of all variables (including the treatment variable) in the DiD analysis (Heider and Ljungqvist, 2015). In our analysis we use the first differences of all variables and our specification is as follows.

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amended version of the bill, applying only to companies with earnings more than $10 million, would tax companies based on the gap is between the highest and lowest paid employees. California corporations would face a tax increase from 10.84% to as much as 14.84%, while California-domiciled financial institutions are looking at a possible increase from 12.82% to 16.84%. Read more in the *Sacramento Bee*, January 17, 2020 (https://www.sacbee.com/opinion/california-forum/article239287588.html#storylink=cpy) and the *California Globe*, February 24, 2020 (https://californiaglobe.com/section-2/california-businesses-could-face-higher-taxes-based-on-gap-between-highest-and-lowest-wages/).

$$\Delta Ln(y_{m,t}) = \beta_0 + \beta_1 \cdot Tax\ Increase_{m,t-2} + \beta_2 \cdot Tax\ Increase_{m,t-1}$$
$$+\beta_3 \cdot Tax\ Decrease_{m,t-2} + \beta_4 \cdot Tax\ Decrease_{m,t-1} + \Delta X_{m,t-1} \cdot \Gamma \quad (1)$$
$$+\mu_m + \vartheta_t + \varepsilon_{m,t},$$

where *m* is the CEO index, *t* is the year index, $Ln(\cdot)$ is the natural logarithm function, *y* is a variable to investigate, such as total compensation or its components, $\Delta$ is the first difference operator (within CEO-firm), $Tax\ Increase$ ($Decrease$) is the tax shock dummy specific to the domicile of the CEO's employer, which equals one if a state experiences an increase (decrease) in personal income tax rate greater than 1% in a year and zero otherwise,[7] *X* is the vector of control variables (including characteristics of the firm that employs the CEO), $\Gamma$ is the coefficient vector for the control variables, $\mu_m$ is the CEO fixed effect, $\vartheta_t$ is the year fixed effect, and $\varepsilon_{m,t}$ is the error term. The control variables in *X* can be transformed using the natural logarithm function, scaled, or not transformed at all. Here and throughout $\Delta X_{m,t-1}\Gamma + \mu_m + \vartheta_t$ is meant to capture determinants, other than tax rate changes, of the change in CEO pay. The coefficients $\beta_1$ to $\beta_4$ show the treatment effects in the DiD analysis. For example, when y is CEO compensation, a significantly positive $\beta_1$ would show that CEO compensation is increased significantly two years following a large increase in state personal income tax rate.

We also investigate the elasticity of compensation to personal income tax changes. To capture accurately the implications for after-tax income of changes in personal income tax rates, we consider the tax rates at both the state level and the federal level in the elasticity analysis.[8] In

[7] The tax shock dummies Tax Increase and Tax Decrease are equal to the first differences of the corresponding treatment count variables, per Appendix Figure IA2.

[8] In our DiD analysis we only use state-level changes in personal income tax rates because a federal tax change affects all firms and no treated or control firms can be defined based on such a federal tax shock..

particular, we use the ratio of the pre-tax-change (year *t*-*r*) net-of-tax rate to the post-tax-change (year *t*) net-of-tax rate: $(1-\tau_{f,t-r}-\tau_{s,t-r})/(1-\tau_{f,t}-\tau_{s,t})$. As we discuss in more detail in Section 8 below, when the sum of the federal and state tax rates changes, this ratio determines the proportional change in pay that would exactly offset the tax increase, thereby making the executive "whole.". The ratio increases (decreases) when the sum of the federal and state tax rates increases (decreases).

## 3. Sample Construction

We obtain data on personal income tax rates from the official website of the tax policy center.[9] As Panel A of Table 1 reports, over the period 1992 – 2018 there were 347 changes in the top state personal income tax rates. Of these, 109 (238) were increases (decreases), and 38 (309) were large (small) changes of at least (less than) 1%.

We obtain compensation data from Execucomp, corporate accounting data from Compustat, and insider trading data from Thomson Reuters. We extract the information on states where firms' executive offices are located directly from SEC 10K filings.[10] Our sample reflects the merged intersection of the Execucomp and Compustat datasets. We only include CEOs who have worked in their current positions more than two years, so that their compensation in the current firms can be affected by the tax changes in the past couple of years and so that CEO moves across firms do not garble the compensation data. Over 1992 – 2018, the final sample includes 38,786 CEO-firm-

[9] https://www.taxpolicycenter.org

[10] We do not have the personal residence address of the executives, so we assume firms' executives live in the states where their offices are located. To identify the relevant state for personal income tax rates, we use the "Mail Address" in 10K filings, which is the HQ address or the "Address of principal executive offices" for the firm.

year observations. Panel B of Table 1 reports additional summary statistics. About 5.3% (1.4%) of CEO-year observations reflect an increase (decrease) in the CEO's top personal income tax rate of 1% or larger.

For compensation measurement, we use the method described in Coles, Daniel, and Naveen (2013). We deploy their associated code[11] to calculate the value and incentive properties of cash, equity, and option awards to executives and the value and incentive properties of the accumulation of those awards (net of dispositions) as they comprise the executive's portfolio. The average CEO in our sample earns US$4.77M per year: $711K in salary, $339K in cash bonus; $632K in non-equity incentive pay; $1.37M in stock; $1.14M in options; and perquisites valued at $197K.

Following the existing compensation literature, we control for the book value of assets, market-to-book ratio and CEO-firm performance (ROA) in our tests. In terms of firm-related control variables, the firm-year average in our sample is $10.1B for book assets and 3.07 for market-to-book. In general, we include manager fixed effects to control for time-invariant manager characteristics and year fixed effects in our analysis.

## 4. Results on the CEO Pay Response to Personal Income Tax Rate Changes

### *4.1. Do state personal income tax rate changes depend on CEO pay changes*

We use state-level income tax changes as plausibly exogenous shocks to the tax rates and study the tax effects on executive compensation. One important assumption is that executive pay changes do not cause tax rate changes. It is possible that high growth in executive pay triggers regulatory

[11] See https://astro.temple.edu/~lnaveen/documents/deltavega_2013.sas.

intervention in the form of a higher marginal tax rate for high earners, such as top corporate executives.

To assess this possibility,

the dependent variable is an indicator *Tax Increase* (*Decrease*) at the state level, which equals one if a state experiences an increase (decrease) in personal income tax rate greater than 1% in a year and zero otherwise. We use the linear probability model and consider the effect of CEO pay growth in a state one and two years prior, controlling for state characteristics including state debt, state GDP, tax revenues, cash savings, population, democrat government indicator, and unemployment rate. We include state and year fixed effects. CEO pay growth is the average change in firm-level CEO pay within a state-year. Table 2 reports the results, which show that coefficients of CEO pay growth in the previous two years are not statistically significantly different from zero for both tax increases and decreases. State-level personal income tax changes do not appear to be associated with prior CEO pay growth in the states, and it likely is valid to use the tax changes as exogenous shocks in our study.

*4.2. The Magnitude and Timing of the Compensation Response to Tax Shocks*

To investigate the effect of personal income tax on CEO compensation, we use a DiD approach as described in Section 2. For the DiD analysis, we first check the parallel trends condition before carrying out the relevant regression analysis. Accordingly, we compare CEO pay changes [Δln(TDC1)] in the treated group and the control group in years around a shock (tax increase or decrease) to state top personal income tax rate. We investigate tax increases and tax decreases separately and they share the same control group in which firms headquartered in states without tax changes.

Specifically, for tax increases, the treated group includes CEOs of firms headquartered in states with personal income tax rates increased by at least 1%. We consider a six-year window around a tax increase, i.e. two years before and three years after a tax increase. In each year (relative to the event year), we first calculate the CEO pay changes at the CEO-firm-year level, which will be used as the dependent variable in our DiD regression analysis. We then take the yearly average within the treated group and the control group, and calculate the difference between the group yearly averages. We plot the yearly differences in Panel A of Figure 2. The blue dots represent the average yearly differences in CEO pay changes [$\Delta$ln(TDC1)] between treated and control groups, i.e. in a DiD framework. The upper and lower bounds of the bars show the 90% confidence intervals. The red dashed line indicates the zero value of the y-axis. This figure shows that in years before the event year (year 0), i.e. year -2 and year -1, the differences between treated and control groups are not statistically different from zero, which confirms that the parallel trend condition is satisfied. The figure also shows that the only year in which treated and control firms have significantly different CEO pays is the year +2, i.e. two years after a tax increase.[12]

Panel B of Figure 2 shows a similar figure for large tax decreases, in which treated group includes CEOs of firms headquartered in states experiencing personal tax rate decreases greater than 1%. The figure shows that in years before the event year (year 0), the differences between treated and control groups are not statistically different from zero, which confirms that the parallel trend condition is satisfied. Interestingly, the figure also shows that in years after a tax decrease

[12] In the online Appendix Figure IA1 (Panel A), we extend the time window until five years after a tax increase to check if a tax increase would have further long-run effect on CEO pay. The figure shows that there is no significant difference between treated and control groups in years +4 and +5. It confirms that the tax effect on CEO pay only appears in the second year following tax increases. Panel B of Appendix Figure IA1 shows a similar figure for tax decreases with the extended time window.

there are no significant differences between treated and control groups. It suggests that unlike tax increases, tax decreases may not have significant effects on CEO compensation.

In our DiD regression analysis, we consider changes in CEO compensation both one and two years after shocks to top personal income tax rates. In the US, personal income taxes in year $t$ usually need to be paid no later than April in year $t$+1, when the liquidity issue and equity sales of CEOs may trigger boards' attention to redesign compensation contracts. Benchmarking and pay-formation processes used by large, listed US firms generally include lags in data and response. The human resources director and board compensation committee, often in collaboration with a compensation consultant, set pay based on lagged pay data for size- and industry-based comparison firms and with a lag in pay determination based on those data (Murphy, 1999). The compensation consultant will collect compensation data on the various positions (CEO, CFO, SVP, Chief Legal Officer, Division Head, SVP, etc.) from those comparable companies and, as the benchmark, pick the median, mean or appropriate percentile, based on where the executive resides in effectiveness and performance relative to peer executives. Usually the new compensation contracts will be effective one year later, i.e. in year $t$+2. Accordingly, we expect a lag of two years for a response, if any, to a change in the personal income tax rate. This prediction is also consistent with Figure 2. Our specification is the Equation (1) as shown in Section 2 and the dependent variable is $\Delta \ln(TDC1)$.

Panel A of Table 3 presents the results when the dummy variables indicate large tax shocks. Column 1 (2) shows the estimates of the effect on CEO compensation of tax increases (decreases) one year and two years prior. Column 3 includes indicator variables for both tax increases and decreases. The results show that CEO compensation significantly increases two years after a large tax increase. For example, Column 1 (3) shows that the CEO compensation increases by 5.5%

(5.7%) two years after a large state tax increase. We observe no significant changes in compensation in the adjacent lagged year of a tax increase. On average it takes two years for CEO pay to adjust following a tax increase.[13]

In stark contrast, there is no decrease in compensation following a tax decrease. The estimates indicate asymmetric effects of tax increases versus tax decreases on CEO compensation.

*4.3. Components of Compensation Affected by Tax Shocks*

The components of CEO compensation evolve over time and stock pay has become the most important part since 2006, as shown by Figure 3. To examine the effects of tax changes on the components of CEO compensation two years after tax increases, we estimate the following model:

$$\Delta Ln(yc_{m,t}) = \beta_0 + \beta_1 \cdot Tax\ Increase_{m,t-2} + \beta_2 \cdot Tax\ Increase_{m,t-1} + \Delta X_{m,t} \cdot \Gamma + \mu_m + \vartheta_t + \varepsilon_{m,t}, \quad (2)$$

where *m* is the CEO index, *t* is the year index, *yc* is the component of CEO pay (e.g., cash or equity pay), and other notation is the same to those in Equation (1). Panel B of Table 3 presents the results.

Including controls and fixed effects, both salary cash pay (Column 1) and stock pay (Column 4) increase significantly two years following a large increase in personal tax rates. Specifically, two years after a large tax increase, cash pay increases by 1.2% and stock pay increases by 12.6%, all else equal. The larger adjustment of compensation in response to tax increases is to equity-based pay in the form of stock granted. Another component of pay that is significantly increased

[13] In our sample period, there are four significant federal income tax changes (exceeding 1%). The results of our DiD analysis are robust if we consider both federal and state personal income tax shocks, as shown in Internet Appendix Table IA1. We also investigate the tax effects on the compensation of non-CEO named executive officers (NEOs) and find that the effect on NEO pay is not statistically significant at the 10% level, as shown in the Internet Appendix Table IA2.

is the non-equity incentive pay (15.9%), for example, cash pay if a sales target is reached. We do not observe, however, a significant change in option pay. The changes in components of CEO pay show that boards usually increase both cash pay for the liquidity issue faced by the CEOs and incentive pay that strengthens the interest alignment between CEOs and shareholders.

*4.4. Neighboring states as control states: robustness tests*

A potential concern about our identification is that local economic situations may affect both executive compensation and local tax policies that are not removed in our baseline tests in which treated and control firms can be in different states far away from each other. To address this concern, we restrict control firms to be the treated states' bordering states that tend to have similar local economic conditions. In particular, for each treated state with large tax shocks, we only include control states that are bordering states that never experience large shocks to personal income tax rates (as illustrated in Figure 4). This setting allows us to get rid of the effects of unobserved variation in local economic conditions and mitigate the possibility of regional confounds.

Table 4 reports the results. The effects of tax increases on CEO pay remain positive and statistically significant (Columns 1 and 3), while the effects of tax decreases remain insignificant (Columns 2 and 3). These findings are consistent with the results in our baseline tests reported in Table 3. It confirms that our findings are robust to controlling for local economic conditions.

*4.5. Additional Considerations*

Several further considerations warrant brief attention. First, suppose a CEO switches firms. Such a move and the likely substantial change in compensation such a move generates (Coles, Li, and Wang, 2018) can reflect the elasticity of demand for CEO input and CEO versus firm

bargaining power, though likely not CEO entrenchment.[14] Demand elasticity and relative bargaining power, as well as the location of the demand curve, potentially can vary across firms, such as the prior versus new employer. Accordingly, so as to better hold constant firm characteristics and to maintain the intersection of CEO and firm, we restrict observations on the change in compensation to include those for which the CEO stays at the same firm for the two years following the relevant change in the personal income tax rate.

Second, about 2.5% of our sample of CEO-year observations have a tax change in two consecutive years. First-differencing removes unobserved firm-specific fixed effects in the corresponding levels equation. In doing so, our specification accommodates: repeated treatments (the possibility that a firm experiences a sequence of tax increases or tax cuts over its time in the panel); treatment reversals (a tax increase followed sometime later by a tax cut, or vice versa); manager turnover; and asymmetry in firms' responses to tax changes. See Heider and Ljungqvist (2015).

Third, significant elements of our empirical analysis rely on the idea that changes in TDC1 (Execucomp, as adjusted per Coles et al., 2013) reflect pay adjustments that arise in response to changes in the personal income tax rates that are applied to taxable income. To examine this notion in more detail, note that total compensation includes some or all of annual salary, annual bonus, and long-term cash bonus, as well as the grant date fair value (GDFV) estimates for stock and option awards. While annual salary and bonus are part of taxable income in the year they are paid, the grant date fair values of stock and option grants are not. Under standard time-based vesting,

[14] Fee and Hadlock (2003) confirm that CEOs who move obtain higher pay and that the compensation change can be explained in part by the equity position forfeited at the prior employer and by the prior employer's performance.

the receipt of stock and options occurs in the future, with the actual taxable date and taxable value being uncertain at the time of the award.[15] Performance-vesting provisions (Bizjak et al., 2010, 2018), under which the number of units of cash, stock, or options ultimately received depends on one or more accounting or market performance metrics, introduces additional uncertainty about actual taxable income.

Of course, in calculating/estimating the value of stock and option awards, compensation committees and consultants often apply standard, SEC/FASB-sanctioned methods to capture the range and likelihood of possible outcomes (Bizjak et al., 2018). The very act of generating a grant date fair value to disclose requires some understanding of these uncertainties. Thus, GDFV potentially provides a reasonable estimate of the present discounted taxable value of those awards. Furthermore, even if GDFV is biased one way or another relative to the present value of taxable income, if the bias is similar from year to year then there is some hope that using the *change* in GDFV removes some of that bias, so that $\Delta Ln(y_{m,t}) = Ln(y_{m,t}) - Ln(y_{m,t-1})$ is a reasonable proxy for the change in the discounted value of taxable income. This reinforces the use of $\Delta Ln(y_{m,t})$ on the left-hand side of regression specifications.

## 5. CEO Equity Sales and Wealth-Performance Sensitivity

The consequences for CEOs and firms of personal income tax rate changes extend beyond adjustments by the firm in the level of pay. In this section, we examine the effects on equity sales

[15] A stock award is taxed at the ordinary rate at market value at the time it vests. If the executive holds the stock, then subsequent tax is based on the gain or loss since vesting at either the ordinary income tax rate or the favorable capital gains rate, depending on holding period since vesting. Options are taxed at exercise, with the ordinary rate applied to the difference between the market value of the stock acquired net of the exercise price. Again, if the executive continues to hold the stock, then subsequent tax is based on the gain or loss since exercise and either the ordinary income tax rate or the favorable capital gains rate applies, depending on the holding period.

by the CEO, the composition of the pay package awarded by the firm in response, and revision of the incentive properties of the CEOs accumulated portfolio of stock and options.

*5.1 Equity Sales, the Tax Bill, and the Composition of Pay*

A significant income tax increase is likely to affect a CEO's liquidity needs because the increased personal tax obligation needs to be paid in cash. One potential mechanism is for the CEO to sell vested stock acquired through prior awards of shares. To test the effects of income tax shocks on CEO equity sales, we estimate the following regression model:

$$\Delta Ln(\$Shares\ Sold_{m,t}) = \beta_0 + \beta_1 \cdot Tax\ Increase_{m,t-2} + \beta_2 \cdot Tax\ Increase_{m,t-1} + \Delta X_{m,t-1} \cdot \Gamma + \mu_m + \vartheta_t + \varepsilon_{m,t}, \quad (3)$$

where \$*Shares Sold* is the dollar value of equity sold by the CEO as an insider, and the other notation is the same as above.

Table 5 reports the results. Column 1 shows that CEOs sell significantly more shares both one and two years after a large tax increase than they do otherwise. This is consistent with the hypothesis that CEOs sell a larger amount of their firm-related equity resulting from the liquidity required to satisfy a larger tax bill.

We note that a CEO could be motivated to liquidate shares due to negative, private, non-public information they possess. It is unlikely, however, that increases in personal tax rates are correlated with negative firm-level information. Nonetheless, to address this concern, we test whether CEOs exercise more options. In specification (3) we replace *$Shares Sold* by *$Options Exercised*, which is defined as the number of options exercised multiplied by the exercise price per share. If CEOs sell more stock due to negative private information, we would expect that they also exercise more

options, the reason being that the value of options also is quite sensitive to negative information. Column 2 of Table 5 shows that the effect of tax increases on options exercised is statistically insignificant. It appears that CEOs decrease their equity holdings due to liquidity reasons rather than based on negative, non-public information.

These findings are consistent with the results on the cash and equity composition of CEO pay in Panel B of Table 3. They imply that the compensation committee of the board of directors, advised by a human resources director and potentially a compensation consultant, appear to be aware of the CEO's need for liquidity and for replacement of equity incentives, both needs arising from the personal income tax increase. For example, Column 1 of Panel B in Table 3 indicates that firms award more cash to the CEO following a personal income tax increase, all else equal. Moreover, as the coefficient on the twice-lagged tax increase indicator in Column 4 (Panel B of Table 3) establishes, firms respond with even larger grants of stock, likely in part to replace prior and anticipated sales of shares by the CEO.

*5.2 The Incentive Properties of CEO Pay: After-Tax Delta*

As CEOs sell their firm's shares and thus reduce their firm-related wealth, the alignment between CEO incentives and shareholder interests erodes. As we argue in the introduction, an increase in the personal income tax rate weakens the after-tax CEO incentive to increase shareholder wealth. The board of directors will recognize this and adjust pre-tax delta upward to recover appropriate after-tax CEO incentives.

We measure wealth-performance sensitivity (WPS) by delta, which is defined as the change in the value of the CEO's accumulated portfolio of stock and options for a 1% change in stock return (e.g., Coles, Daniel, and Naveen, 2006). As reported in Table 1, the average CEO delta is $517K.

Equivalently, a 1% increase in firm value leads to an increase in CEO firm-related wealth of $517K. We estimate the following model.

$$\Delta Ln(delta_{m,t}) = \beta_0 + \beta_1 \cdot Tax\ Increase_{m,t-2} + \beta_2 \cdot Tax\ Increase_{m,t-1} + \Delta X_{m,t-1} \cdot \Gamma + \mu_m + \vartheta_t + \varepsilon_{m,t}. \quad (4)$$

Table 6 shows results for delta based on the large tax increase dummy. The estimates indicate that delta increases two years after a large tax increase. The coefficient on the large tax increase indicator variable is statistically significant at the 5% level.

## 6. The Role of Industry Profitability: Share a Larger Pie

Higher personal income tax rates decrease CEO after-tax pay and give the CEO reason to pursue higher before-tax pay through negotiations with the compensation committee of the board. It is usually relatively easier to bargain for higher pay if the firms are more profitable, so as to share a larger pie with shareholders. We thus expect the effects of tax increases on CEO compensation to be stronger in more profitable firms. Better firm-level performance, however, can be correlated with CEO performance. Therefore, we split our sample into two subsamples by yearly median based on industry-level median profit margin [(Sale – COGS)/Sale], where the industry classification is based on the two-digit SIC. We then analyze each subsample using the following specification.

$$\Delta Ln(TDC1_{m,t}) = \beta_0 + \beta_1 \cdot Tax\ Increase_{m,t-2} + \beta_2 \cdot Tax\ Increase_{m,t-1} + \Delta X_{m,t-1} \cdot \Gamma + \mu_m + \vartheta_t + \varepsilon_{m,t}. \quad (5)$$

Table 7 reports the results. Column 1 shows the result for the high-profit group and Column 2 shows the result for the low-profit group. The coefficient estimate of the twice-lagged tax increase dummy is significant only in the high-profit group. The estimate on the large-tax-increase dummy for firms in more profitable industries more than doubles those when all firms are included (Column 1, Panel A, Table 3). The results confirm that profitability amplifies the effects of tax increases on CEO compensation.

## 7. CEO Turnover, Firm Performance, and CEO Pay raises

### *7.1 CEO Turnover and CEO Pay Raises*

When a CEO experiencing an increase in personal income tax rate fails to get a pay raise in the current firm, she may search for a similar or better position elsewhere. In practice, a new position generally is accompanied by a signing bonus and a pay increase. Affected CEOs may move to a different state where personal income tax rate is lower.[16] Such CEO turnovers potentially have adverse effects on current firms. For example, when a current CEO leaves her position, the board needs to seek a successor. The potentially urgent search likely gives CEO candidates additional bargaining power to negotiate higher pay. Furthermore, non-disclosure agreements and non-compete clauses often have limited enforceability (Garmaise, 2011), in which case a departing CEO can take key information on the now-former employer to the rival firm. Finally, an unhappy exiting CEO may be less cooperative during the transition to exit, which can have negative effects

[16] In a related investigation, we collect CEO-to-CEO switcher cases using Execucomp data and find that when a CEO moves to the next CEO positive, in 80% of cases the CEO moves to a different state, which implies that geographical stability is usually not a rigid job search restriction for CEOs.

on existing long-run projects. To what extent is a response to increased personal income tax rates in the form of higher pay an effective means for retention?

To assess the presence of the retention motive, we divide firms with CEOs who face a large increase in personal income tax rates into two groups. One group includes CEOs who receive a pay raise two years after the large increase in income tax rates. The other group includes CEOs who suffer from a large tax increase but do not receive a pay raise in the same period two years after. We compare the likelihood of CEO turnover two years after increases in tax rates across these two groups.

Panel A of Table 8 reports the univariate comparison of turnover rates. We find a significant difference in the likelihood of CEO turnover between the groups with and without CEO pay raises. Specifically, in the firms that do *not* give their CEOs pay raises, there are 153 turnovers that count for 10% of CEO-firm years in this group. In contrast, in firms that give their CEOs pay raises, there are only 101 turnovers that only count for 4.5% of CEO-firm years in the got-a-pay-raise group. A *t*-test for the equality of turnover rates between these two groups indicates that the means are statistically different at the 1% level (*p*-value 0.001). The likelihood of CEO turnover in the pay-raise group is significantly lower than that in the no-pay-raise group.

One possibility is that the CEOs who get no raise are less capable. For example, bad performance in previous years might happen to drive CEOs to leave their positions and lead firms by not responding to allow CEOs to depart. To address this possibility we control for firm performance in the previous one and two years in a regression model. For CEOs who faced an increase in personal income tax rates two years prior, we estimate the following linear probability model:

$$CEO\ Turnover_{m,t} = \beta_0 + \beta_1 \cdot PayRaise_{m,t-1} + X_{m,t-1} \cdot \Gamma + \mu_i + \vartheta_t + \varepsilon_{m,t}, \qquad (6)$$

where *Turnover* is an indicator variable for CEO turnover and $PayRaise$ is the pay raise dummy (= 1 if the CEO received a pay raise within two years of the tax rate change, 0 otherwise). Control variables include ROA or stock return and other firm characteristics.

Both columns in Panel B show that the coefficients on the pay raise dummy are negative and statistically significant at the 5% or 10% level. It appears that CEOs receiving pay raises are significantly less likely to depart than those who do not receive a raise following a tax increase.

*7.2 Firm Performance Following CEO Pay Raises*

Would higher CEO pay following an increase in income tax rates be associated with better or worse subsequent firm performance? In this section, we focus on firms whose CEOs experienced an exogenous personal income tax rate increases two years prior and again partition the sample based on whether the CEO received an increase in compensation. We measure firm performance by ROA and stock return. Panel A of Table 9 shows the univariate results. The change in ROA and stock returns from year *t-1* to *t* is higher in firms that gave raises to their CEOs in period *t-1* following a tax hike in the previous two years.

A multivariate setting provides similar results. We estimate the following model.

$$\Delta Performance_{i,t} = \beta_0 + \beta_1 \cdot PayRaise_{m,t-1} + \Delta X_{m,t-1} \cdot \Gamma + \mu_i + \vartheta_t + \varepsilon_{m,i,t} \qquad (7)$$

where *i* is the firm index, $PayRaise$ is the pay raise dummy, $\mu_i$ is the firm fixed effect, and $\varepsilon_{m,i,t}$ is the error term.

A potential concern could be that CEOs that made bad decisions do not get a raise, whereas better performing CEOs get a raise. Put differently, the past performance might be an omitted variable. To address such concerns, we control for firm performance in the previous one and two years. In the meanwhile, the dependent variable $\Delta Performance$ is measured one year forward

from the period in which the CEO did or did not receive a pay increase (in response to a large tax increase two years prior). Panel B reports the results.

ROA (Column 1) and stock return (Column 2) are significantly higher for firms that increase CEO pay following a large personal income tax increase, after controlling for the firm performance in the previous years. Put differently, if a firm does not increase CEO pay after a large state tax increase, the firm performance tends to be worse. These findings are consistent with the idea that boards can offset negative compensation shocks unrelated to CEO performance/quality and, by doing so, retain valuable talent to enable good firm performance.

## 8. The Elasticity of CEO Compensation in Personal Taxes

To further assess the economic significance of the responsiveness of CEO pay to personal taxes, in this section, we estimate the elasticity of CEO compensation with respect to the factor that captures what is left after income taxes, the net-of-tax rate.[17] To measure the economic magnitude of tax changes more accurately, we consider both federal level and state level changes in personal income tax rates in our analysis on the elasticity.

### *8.1. Theoretical framework*

Let $y_{m,t}$ be nominal period $t$ compensation of CEO $m$ and let $\tau_{m,f,t}$ and $\tau_{m,s,t}$ be the federal and state tax rates applicable to CEO $m$ in period $t$. After-tax, period-$t$ pay (or wealth increment) of the CEO of the firm is $y_{m,t} \cdot (1 - \tau_{m,f,t} - \tau_{m.s,t}) = y_{m,t} \cdot NOT_{m,t}$, where $NOT_{m,t} \equiv (1 -$

[17] The income tax in the US can include three parts: federal, state, and local. In contrast to federal and state income taxes, local income taxes are low (most local income tax rates are between 1% to 3%, with a few exceptions, including the District of Columbia, with the income tax rate ranging from 4% to 8.5%. More information is available at https://taxfoundation.org/local-income-taxes-city-and-county-level-income-and-wage-taxes-continue-wane/.). Therefore, in our calculations, we approximate the income tax rate as the sum of federal and state income tax rates and ignore local income tax.

$\tau_{m,f,t} - \tau_{m,s,t}$) is the "net of tax" rate, which is the rate applied to taxable income to determine after-tax income. Let $g_{m,t}$ be the one-year labor-market equilibrium growth rate for the pay of the CEO. The rate $g_{m,t}$ could depend on the level of or changes in firm accounting or market performance, size, asset tangibility, inflation rate, performance of industry competitors, other factors, and on CEO characteristics as well.

*8.2. Empirical findings on elasticity of CEO compensation in personal income tax changes*

Suppose that $(1 + g_{m,1})y_{m,0}$ is the right benchmark for the CEO's pay in period 1. Let $\hat{y}_{m,1}$ denote the nominal pay of the CEO in period 1 that makes the CEO whole after-tax, holding all else constant: $\hat{y}_{m,1} \cdot (1 - \tau_{m,f,1} - \tau_{m,s,1}) = (1 + g_{m,1}) \cdot y_{m,0} \cdot (1 - \tau_{m,f,0} - \tau_{m,s,0})$ , or identically, $\hat{y}_{m,1} \equiv (1 + g_{m,1}) \cdot (NOT_{m,0}/NOT_{m,1})y_{m,0}$. Dividing both sides by prior pre-tax pay and allowing that tax rate changes can affect pay potentially with a lag suggests the following specification to estimate the effect on CEO pay of a change in the personal income tax rate:

$$Ln\left(\frac{y_{m,t}}{y_{m,t-1}}\right) = \beta_0 + \beta_1 Ln\left(\frac{NOT_{m,t-3}}{NOT_{m,t-2}}\right) + \beta_2 Ln\left(\frac{NOT_{m,t-2}}{NOT_{m,t-1}}\right) + \Delta X_{m,t-1}\Gamma + \mu_m + \vartheta_t + \varepsilon_{m,t}, \quad (8)$$

where *m* is the CEO index, *t* is the time index, *y* is CEO compensation, $NOT_{m,t}$ is the after-tax adjustment as defined above, and other notation is defined prior. Because we expect the response, if any, to be lagged by two years, the coefficient $\beta_1$ is our focus. We expect the estimate of $\beta_1$ to be positive because an increase in tax rate(s) from $t - 3$ to $t - 2$ implies an increase in the *NOT* ratio, $NOT_{m,t-3}/NOT_{m,t-2}$. If compensation responds sooner, $\beta_2$ should be positive.

In either case, the estimated coefficient from model (8) is the **negative** of the elasticity of executive pay in the net-of-tax rate, $\varepsilon_{y,NOT} \equiv (NOT/y)(dy/dNOT)$. Restated, the estimated coefficient would be equal and opposite in sign if we perform the regression analysis based on $NOT_{m,t-2}/NOT_{m,t-3}$, the reciprocal of the after-tax ratio used in model (8).

Table 10 reports the results. Columns 1 and 2 of Panel A compare large and small changes in personal income tax rates. For large (small) tax rate changes, we set $NOT_{m,t-s}/NOT_{m,t-(s-1)} = 1$ for all observations for which the rate change was less than (greater than or equal to) 1%. Column 1 indicates that a 1% increase in the net-of-tax rate due to large tax changes is associated with a 1.251% increase in total compensation two years later. The elasticity estimate for large increases in Column 3 is much larger at 1.987%. An estimate of 1 would be consistent with an increase in pay that makes the CEO exactly whole in terms of after-tax pay. Both estimates indicate that the CEO is more than fully compensated for the increase in personal income tax rate two years prior.

To illustrate further the economic significance of the parameter estimate, suppose the state or federal tax rate (or the sum of those rates) goes up by 0.01 from period $t-3$ to $t-2$. Assume that prior to the tax increase that the federal and state rates are the CEO-year averages in the sample, 36.4% and 5.3%, respectively, so the federal and state rates sum to 0.417 at $t-3$ and 0.427 at $t-2$. Then $Ln(NOT_{m,t-3}/NOT_{m,t-2})$ becomes .0173 rather than 0, which the logarithm of the net-of-tax ratio would be if there had been no tax rate change. Using the upside elasticity estimate (Column 3) implies a 3.44% (i.e. 1.987 x 0.0173) proportional increase in CEO pay.

Columns 3 and 4 contrast tax increases and decreases. The results indicate that tax increases result in higher pay (Column 3), while tax decreases have no effect on pay (Column 4). The asymmetric elasticity results are consistent with the asymmetric effects reported in Table 3.

Note that our estimates indicate that there is very little response to the more recent tax rate change ($t-2$ to $t-1$). Finally, per Column 2, we find no significant changes in CEO pay associated with small tax changes.

*8.3. Discussion of the Elasticity Estimates*

Both the very strong response upward in CEO pay to tax increases and the lack of responsiveness of CEO pay to tax decreases are provocative results that beg for additional inspection. Here we consider whether there is a combination of standard supply and demand effects that can explain the collection of results.

To do so we address whether the empirical estimate of $\beta_1$ is consistent with plausible demand and supply conditions for CEO "labor" as a function of "wage." Denote equilibrium executive compensation as $y$, the sum of the federal and state tax rates as $\tau = \tau_f + \tau_s$, and CEO pay after income tax as $y \cdot (1-\tau) = y \cdot NOT$. Denote the demand function of the firm for executive "labor" or input as $D(y)$ and the executive's supply function as $S(y \cdot NOT)$. In (partial) equilibrium in the executive labor market, $D(y) = S\big(y \cdot (1-\tau)\big) = S(y \cdot NOT)$ determines the equilibrium level of compensation for a given net-of-tax rate.

Suppose that there is a shock to the net-of-tax rate. The shock could be an increase (a reduction) in federal or state tax rate, in which case $NOT$ would fall (rise). To assess the effect of the tax shock on equilibrium pay, differentiate the expression equating demand and supply in $y$ and $NOT$ to get $D'(y) \cdot dy = S'(y \cdot NOT)[y \cdot dNOT + NOT \cdot dy]$. Solving gives $\varepsilon_{y,NOT} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D)$, where $\varepsilon_{y,NOT} \equiv (NOT/y) \cdot (dy/dNOT)$ and the supply and demand elasticities in the CEO labor market are $\varepsilon_S \equiv y \cdot NOT \cdot S'(y \cdot NOT)/\, S(y \cdot NOT)$ and $\varepsilon_D \equiv y \cdot D'(y)/\, D(y)$. If $\varepsilon_S \in [0, \infty)$ and $\varepsilon_D \in (-\infty, 0]$, then $\varepsilon_{y,NOT} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D) \in [-1,0]$.

Note that both of the estimates of $-\beta_1$ from Table 10, -1.251 from Column 1 and -1.987 from Column 3, fall *outside* of this interval. The former estimate, based on large tax increases and decreases, is statistically indistinguishable from -1.000. If one suspends disbelief to take the Column 1 estimate to be 1, so $\varepsilon_{y,NOT} = -1$, such leads to the conclusion that the demand for CEO input is perfectly inelastic ($\varepsilon_D = 0$), so that the firm fully and exactly compensates the CEO for any increase in personal income tax rate, regardless of the elasticity of supply. Our estimates, however, indicate an even larger responsiveness of pay to shocks to the personal income tax rate.

A leading possibility is that the demand curve is highly inelastic and that, on top of that, the CEO has significant additional bargaining power.[18] The elasticity estimate based on large tax increases and decreases is outside of the $[-1,0]$ interval, the elasticity for large increases only, 1.987, is far outside the interval, and the elasticity for large decreases is insignificantly different from zero. Entrenchment and bargaining power are likely explanations for the lack of downward response to large tax rate decreases. And bargaining power can be deployed more generally by the CEO, so the combination of an inelastic demand curve plus CEO influence is a plausible explanation for the high upward responsiveness of CEO compensation to a large increase in personal income tax rate.

*8.4. Elasticity of Delta in the Net-of-Tax Rate*

We retread model (8) by replacing on the left-hand side $Ln\left(y_{m,t}/y_{m,t-1}\right)$ with $Ln(delta_{m,t}/delta_{m,t-1})$. Panel B of Table 10 generates estimates of the elasticity of CEO delta in the net-of-

[18] Another possible but doubtful explanation is that the board of directors perceives the CEO as being better and more capable the higher is the level of pay. Perhaps the board enjoys conspicuous employment of an expensive CEO (a Veblen good), in which case the firm could respond to an increase in personal tax rate as if the firm's demand curve for CEO input were upward sloping.

tax rate for large and small tax changes and for large increases and decreases. Small tax rate changes and tax rate decreases have insignificant effects on CEO delta. On the other hand, the responses of delta to large tax rate changes and large increases are substantial. For example, the elasticity of delta in the net-of-tax rate for large tax changes is 1.340, which is statistically significant at the 10% level. The elasticity for delta in the net-of-tax rate for large tax increases is even larger, 2.345, and statistically significant at the 5% level. If the elasticities were 1.0, absent equity sales by the CEO, after-tax delta would return to their pre-tax-change levels. Of course, executives do sell stock, in addition to the effect on after-tax delta (with holdings held constant). It appears that boards offset, perhaps even fully or more than fully, the combination of the two negative effects of personal tax increases on CEO after-tax incentives.

## 9. Conclusion

We study the effect of tax policies on CEO compensation. Specifically, we utilize staggered changes in state-level personal income tax rates in the US to investigate how increases and decreases in personal income tax rates affect CEO compensation. We find that two years after a large increase in the personal income tax rate, the CEO receives significantly higher pay that more than offsets the cost of the tax increase. In particular, our estimates indicate that a 1% decrease in the CEO's net-of-tax rate is associated with a 1.251% increase in total compensation two years later. This increase is somewhat more than what would have been required to make the CEO exactly whole after the increase in personal income tax. We find that income tax rate decreases have minimal effects on CEO pay. The effects on CEO pay of tax increases and decreases are decidedly asymmetric.

The form of the pay increase comes in both cash and awards of stock in the firm. The former is consistent with an increase in demand for liquidity by the CEO to pay the larger tax bill. The latter is consistent with maintaining the CEO's after-tax equity incentives. Following a tax rate increase, we find that CEOs sell equity, likely for additional liquidity needed to pay income tax. Equity awards by the firm to the CEO appear to offset those lost equity incentives. Moreover, after-tax delta incentives decline when there is an increase in personal income tax rate, so firms grant equity to increase pre-tax delta to offset the effect of an increase in tax rate.

We find that the tax effect on CEO pay is stronger in more profitable industries. Furthermore, when CEOs experience increases in income taxes, a pay raise is negatively associated with the likelihood of CEO turnover and positively associated with firm performance. This evidence suggests that increases in CEO pay after personal tax increases do not damage shareholder wealth.

Edmans, Gabaix and Jenter (2017) list three perspectives as being particularly useful to understand managerial compensation: market forces and shareholder value maximization; executive bargaining power and rent extraction; and institutional forces, such as taxes. We believe our results reflect all three of those perspectives. The combination of the strong effect of personal income taxes on pay, the magnitude of the elasticities of executive pay in the net-of-tax rate, the asymmetry in the effect of tax increases versus decreases, and the effects of taxes on the incentive properties of executive compensation suggest that market forces and managerial bargaining power shape the way that CEO pay responds to personal income tax rates.

A question we are unable to address without more data is the incidence at the firm level of the shock to the supply curve of the CEO. The firm responds with higher CEO compensation, but we do not know the extent to which that cost is spread across shareholders, bondholders, other labor,

other factors of production, customers, or suppliers. We leave this for future inquiry enabled by appropriate data.

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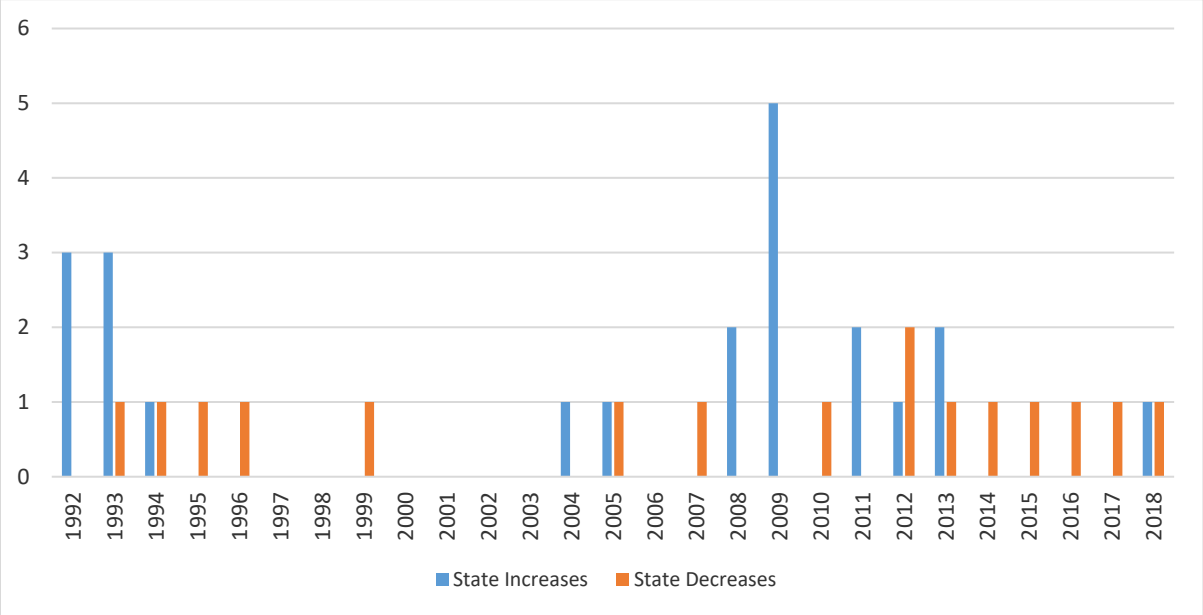
**Appendix: Variable Definitions**

| | |
|---|---|
| Assets | total book value of assets |
| Cash Pay | the natural logarithm of total compensation (TDC1) less stock and option pay |
| Cash | cash and liquid assets held by the firm (scaled by total book assets) |
| Debt | short and long-term debt held by the firm (scaled by total book assets) |
| Democrat Gov | dummy variable equal to one if the state had a democratic governor in a particular year, zero otherwise |
| Delta | the change in firm-related wealth for a 1% change in the firm's stock return, calculated following Coles, Daniel and Naveen (2006) |
| Equity Pay | the natural logarithm of the sum of stock and option pay received |
| HHI | a text-based network Herfindahl measure (TNIC HHI); a higher HHI means lower competition; from the Hoberg-Phillips data library |
| Lerner Index | the median gross profit within a firm's two-digit SIC industry |
| Mkt-Book | the market value of equity (shares outstanding multiplied by share price) divided by the book value of shareholder's equity |
| NOT | $NOT_t \equiv (1 - \tau_{f,t} - \tau_{s,t})$ means "net of tax", where $\tau_{f,t}$ ($\tau_{s,t}$) is the top marginal federal (state) tax rate at time *t* |
| Old CEO | a dummy variable that equals to one if a CEO is at least 65 years old in a year and zero otherwise |
| Pay Raise | the pay raise dummy that equals one if the CEO received a pay raise within two years of the tax rate change and zero otherwise |
| Population | the total state population within a specific year |

| | |
|---|---|
| ROA | net income scaled by total assets |
| R&D | research & development expenditures of the firm (scaled by total book assets) |
| SCash | the total cash of a given state in a specific year |
| SDebt | the total debt of a given state in a specific year |
| State GDP | the gross domestic product within a state-year |
| Stock Return | stock return over a fiscal year |
| Tax Increase | a dummy variable equal to one if a CEO experienced a personal income tax rate increase (greater than 1% in some models), and zero otherwise |
| Tax Decrease | a dummy variable equal to one if a CEO experienced a personal income tax rate decrease (greater than 1% in some models), and zero otherwise |
| Tax Revenue | total tax revenue within a state-year |
| Turnover | dummy variable equal to one if a firm experiences a CEO turnover in a given year, zero otherwise |
| Unemployment | the percentage of workers that are unemployed within a state-year |
| Vega | the change in firm-related wealth for a 0.01 change in the firm's annualized standard deviation of daily stock return, calculated following Coles, Daniel and Naveen (2006) |
| $Options Exercised | the number of options exercised by the CEO multiplied by the exercise price per share, all adjusted for stock splits |
| $Shares Sold | the dollar value of equity sold by the CEO as an insider |

## Figure 1. Large State Personal Income Tax Rate Shocks Over Time

This figure shows the yearly number of large increases and decreases in state-level personal income tax rates between 1992 and 2018, where the large charges are changes exceeding 1% for earners in the top tax bracket. The blue (orange) bars are for increases (decreases) in tax rates.

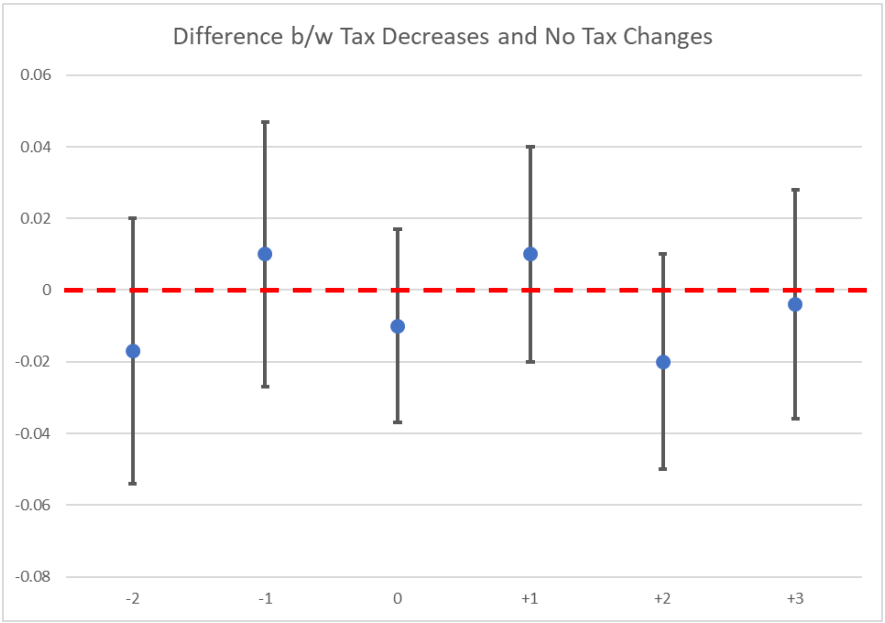


## Figure 2. Differences in CEO Pay Changes Between Treated and Control Groups in Years Around the Tax Changes

This figure shows the differences in CEO pay changes between the treated group and control group. The treated group includes CEOs in firms headquartered in states experiencing large personal income tax rate changes (greater than 1%). The control group includes CEOs in firms headquartered in states without personal income tax changes. Panel A (B) is for tax increases (decreases). The x-axis shows the year relative to an event year (as year 0). The y-axis shows the difference in CEO pay changes [Δln(TDC1), to be used as the dependent variable in DiD analysis]. The blue dots represent the average yearly differences in Δln(TDC1) between treated and control groups. The upper and lower bounds of the bars show the 90% confidence intervals. The red dashed line indicates the zero value of the y-axis.

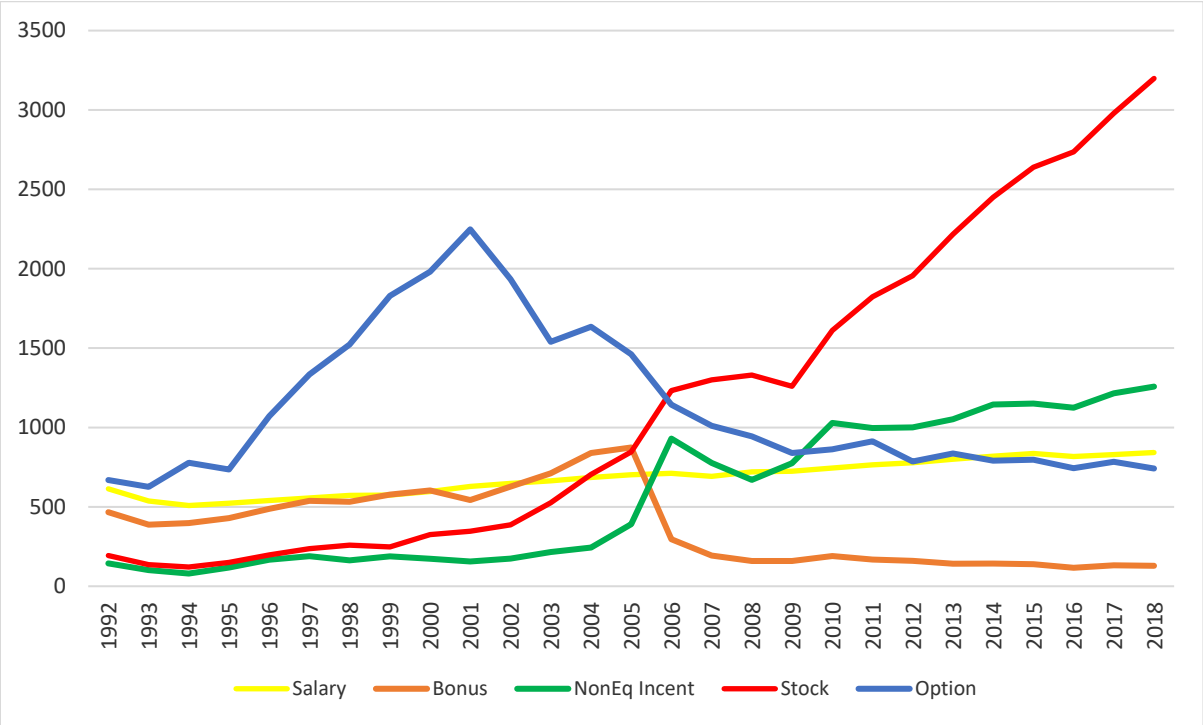
Panel A. Tax increases


Panel B. Tax decreases



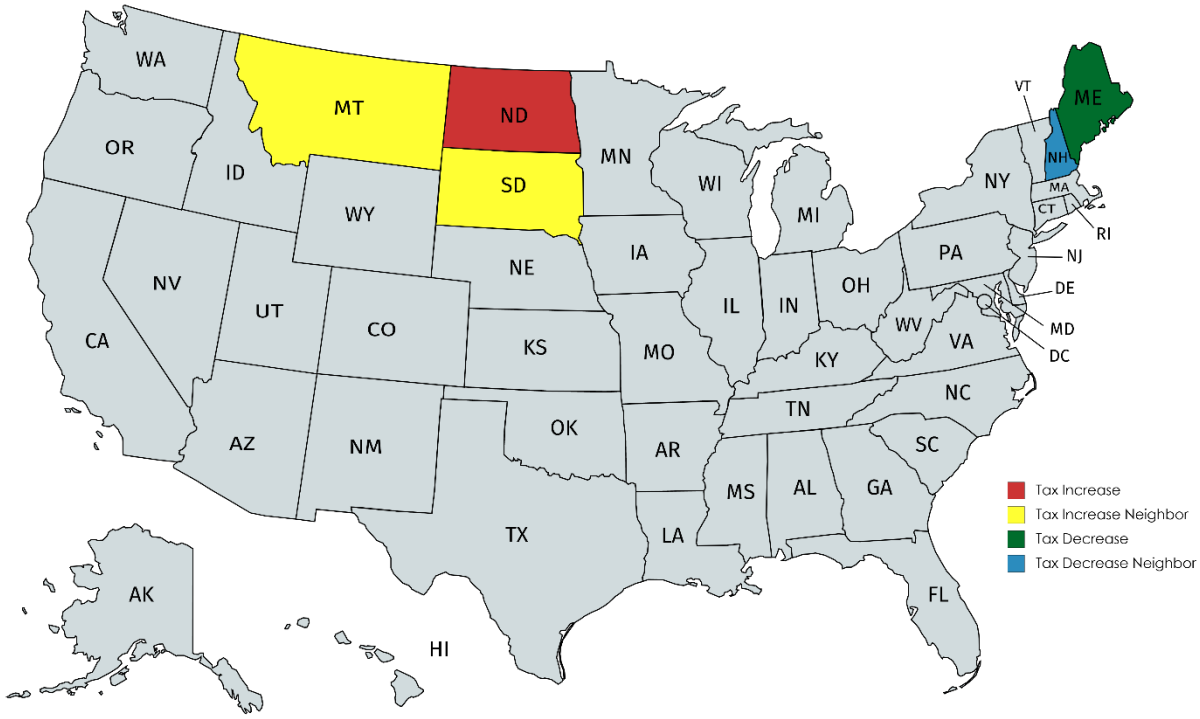
## Figure 3. Components of CEO Compensation

This figure illustrates the yearly average of the components of CEO compensation between 1992 and 2018 inclusive. The components include salary, bonus, non-equity incentives, stock, and options in thousands of US$. The data are from Execucomp.



## Figure 4. Examples for Neighbor States Without Tax Shocks

This figure shows examples for neighboring control states for treated states with tax increases or increases. For example, North Dakota (ND) had a tax increases [in Red]; Montana (MT) and South Dakota (SD) as neighbors without shocks [in Yellow]; Minnesota (MN) had a tax increase, so is not selected as a neighbor control state. In our sample, in total we have 15 (14) unique states with tax increases (decreases) and correspondingly have 20 (21) unique neighboring control states without tax shocks.



## Table 1. Summary Statistics

This table presents summary statistics in Panel A for changes in the top state personal income tax rate. Panel B provides summary statistics at the level of CEO-firm-year on compensation, personal income tax rate changes and firm characteristics. The sample consists of firms in the intersection of Execucomp and Compustat for the years 1992 – 2018 inclusive. The compensation-related variables are in thousands of US dollars. Assets are in millions of dollars. All variables are winsorized at the 1st and 99th percentile values. Variable definitions are in Appendix.

Panel A: State Personal Income Tax Rate Changes

| | Mean%/Count | | |
|---|---|---|---|
| | Increase | Decrease | Both |
| Large | 2.27%/22 | -2.11%/16 | NA/38 |
| Small | 0.25%/87 | -0.22%/222 | NA/309 |
| Total | 0.65%/109 | -0.35%/238 | NA/347 |

Panel B: CEO-Firm-Year Summary Statistics

| | Units = $ thousands | | | | | |
|---|---|---|---|---|---|---|
| Variable | Mean | SD | p25 | p50 | p75 | N |
| CEO-Firm-Year | | | | | | |
| Large Tax Increase | 0.053 | 0.224 | 0 | 0 | 0 | 38,786 |
| Large Tax Decrease | 0.014 | 0.116 | 0 | 0 | 0 | 38,786 |
| Total Pay (TDC1) | 4,774.03 | 4,702.35 | 1,404.00 | 3,096.80 | 6,388.82 | 38,786 |
| Salary | 711.46 | 320.73 | 468.00 | 680.00 | 945.00 | 38,786 |
| Bonus | 338.65 | 624.69 | 0 | 0 | 415.63 | 38,786 |
| Noneq Incentives | 632.48 | 971.66 | 0 | 0 | 957.26 | 38,521 |
| Stock Pay | 1,367.43 | 2,122.27 | 0 | 220.94 | 1,918.67 | 38,521 |
| Option Pay | 1,137.50 | 1,718.18 | 0 | 361.24 | 1,523.38 | 38,521 |
| Perquisite | 196.50 | 387.61 | 13.19 | 54.10 | 183.03 | 38,786 |
| Delta | 517.19 | 787.19 | 75.72 | 203.27 | 557.54 | 37,041 |
| Firm-Year | | | | | | |
| Assets | 10,101.85 | 27,717.88 | 617.95 | 1,914.76 | 6,686.20 | 38,786 |
| Mkt-Book | 3.07 | 3.78 | 1.40 | 2.17 | 3.59 | 38,786 |
| ROA | 0.03 | 0.11 | 0.01 | 0.04 | 0.08 | 38,786 |
| Stock Return | 0.14 | 0.49 | -0.14 | 0.09 | 0.33 | 38,786 |

## Table 2. State Personal Income Tax Rate Changes and CEO Pay Changes

This table shows the relationship between state personal income tax rate changes and CEO pay changes. Tax Increase (Decrease) is a dummy variable, which equals one if a state experiences an increase (decrease) in personal income tax rate greater than 1% in a year and zero otherwise. The CEO pay growth (ΔCEO pay) is the average change in firm-level CEO pay within a state-year. The test sample is at the state-year level. The linear probability model is used and state-level controls include debt, state GDP, tax revenues, cash savings, population, democrat government indicator, and unemployment rate. All specifications include state fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) |
|---|---|---|
| VARIABLES | Tax Increase | Tax Decrease |
| | | |
| $\Delta$CEO pay$_{t-1}$ | 0.016 | 0.004 |
| | [1.14] | [0.33] |
| $\Delta$CEO pay$_{t-2}$ | 0.008 | -0.002 |
| | [0.85] | [-0.10] |
| $\Delta$Ln(SDebt$_{t-1}$) | 0.084* | 0.018 |
| | [1.69] | [0.31] |
| $\Delta$Ln(State GDP$_{t-1}$) | 0.482 | -0.122 |
| | [1.62] | [-0.64] |
| $\Delta$Ln(Tax Revenue$_{t-1}$) | -0.163 | -0.131 |
| | [-1.25] | [-1.55] |
| $\Delta$Ln(SCash$_{t-1}$) | -0.064 | -0.028 |
| | [-1.12] | [-0.59] |
| $\Delta$Ln(Population$_{t-1}$) | -0.421 | 0.259 |
| | [-0.98] | [0.77] |
| $\Delta$Democrat Gov$_{t-1}$ | 0.018 | -0.030 |
| | [1.10] | [-1.50] |
| $\Delta$Unemployment$_{t-1}$ | -0.001 | -0.006 |
| | [-0.11] | [-0.54] |
| | | |
| Observations | 857 | 857 |
| R-squared | 0.121 | 0.072 |
| State FE | Y | Y |
| Year FE | Y | Y |

## Table 3. CEO Compensation Responsiveness to State Personal Income Tax Changes

This table shows the effects of changes in personal income tax rates on CEO compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least 1% in a year and zero otherwise. Panel A (B) shows the effect of tax changes on total pay (components of pay). Total pay is TDC1 in Execucomp database. The dependent variable is total CEO compensation or a component of CEO compensation, the control variables are Assets, Mkt-Book, and 1+ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Magnitude and Timing of the Response

| VARIABLES | (1) ΔLn(TDC1) | (2) ΔLn(TDC1) | (3) ΔLn(TDC1) |
|---|---|---|---|
| Tax Increase$_{t-1}$ | -0.006 | | -0.003 |
| | [-0.32] | | [-0.18] |
| Tax Increase$_{t-2}$ | 0.055*** | | 0.057*** |
| | [2.79] | | [3.07] |
| Tax Decrease$_{t-1}$ | | 0.020 | 0.017 |
| | | [0.57] | [0.49] |
| Tax Decrease$_{t-2}$ | | 0.060 | 0.063 |
| | | [1.37] | [1.50] |
| ΔLn(Assets$_{t-1}$) | 0.324*** | 0.324*** | 0.324*** |
| | [11.27] | [11.13] | [11.13] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.013*** | 0.013*** | 0.013*** |
| | [5.51] | [5.52] | [5.52] |
| ΔLn(1+ROA$_{t-1}$) | 0.543*** | 0.544*** | 0.543*** |
| | [4.78] | [4.77] | [4.78] |
| Observations | 36,709 | 36,709 | 36,709 |
| R-squared | 0.116 | 0.116 | 0.116 |
| CEO FE | Y | Y | Y |
| Year FE | Y | Y | Y |

Panel B: Components of CEO Compensation Responsiveness to Prior Personal Tax Rate Changes

| VARIABLES | (1) ΔLn(Salary) | (2) ΔLn(Bonus) | (3) ΔLn(NonEq Incent) | (4) ΔLn(Stock) | (5) ΔLn(Option) |
|---|---|---|---|---|---|
| Tax Increase$_{t-1}$ | -0.012 | 0.117 | 0.008 | 0.045 | -0.094 |
| | [-1.44] | [1.05] | [0.07] | [0.52] | [-0.81] |
| Tax Increase$_{t-2}$ | 0.012*** | 0.034 | 0.159** | 0.126** | -0.082 |
| | [3.42] | [0.37] | [2.04] | [2.39] | [-0.83] |
| ΔLn(Assets$_{t-1}$) | 0.067*** | 0.422*** | 0.284*** | -0.057 | 0.246*** |
| | [7.18] | [4.98] | [4.10] | [-1.04] | [2.76] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.001 | 0.036*** | 0.024*** | 0.011** | 0.008 |
| | [1.52] | [4.74] | [4.42] | [2.37] | [1.42] |
| ΔLn (1+ROA$_{t-1}$) | 0.017 | 2.754*** | 2.487*** | 0.385** | 0.520** |
| | [0.94] | [17.74] | [7.03] | [2.52] | [2.21] |
| Observations | 36,959 | 36,959 | 36,639 | 33,405 | 33,281 |
| R-squared | 0.263 | 0.156 | 0.168 | 0.236 | 0.211 |
| CEO FE | Y | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y | Y |

## Table 4. Neighboring Control States Without Tax Shocks: Robustness Checks

This table shows the effects of changes in personal income tax rates on CEO compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least 1% in a year and zero otherwise. Column 1 includes tax increase states and neighboring states that have never had a tax rate change. Column 2 includes tax decrease states and neighboring states that have never had a tax rate change. Column 3 includes tax increase states, tax decrease states and neighboring states to both tax increase and tax decrease state that have never had a tax rate change. Total pay is TDC1 in Execucomp database. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| VARIABLES | (1)<br>ΔLn(TDC1) | (2)<br>ΔLn(TDC1) | (3)<br>ΔLn(TDC1) |
|---|---|---|---|
| Tax Increase$_{t-1}$ | -0.006 | | -0.004 |
| | [-0.27] | | [-0.22] |
| Tax Increase$_{t-2}$ | 0.044** | | 0.047*** |
| | [2.71] | | [2.94] |
| Tax Decrease$_{t-1}$ | | 0.022 | 0.014 |
| | | [0.65] | [0.46] |
| Tax Decrease$_{t-2}$ | | 0.050 | 0.058 |
| | | [1.12] | [1.33] |
| ΔLn(Assets$_{t-1}$) | 0.289*** | 0.294*** | 0.322*** |
| | [7.77] | [9.27] | [9.29] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.014*** | 0.013*** | 0.014*** |
| | [7.34] | [7.45] | [5.43] |
| ΔLn(1+ROA$_{t-1}$) | 0.472*** | 0.521*** | 0.548*** |
| | [4.08] | [4.64] | [5.08] |
| Observations | 25,528 | 29,892 | 34,534 |
| R-squared | 0.117 | 0.118 | 0.118 |
| CEO FE | Y | Y | Y |
| Year FE | Y | Y | Y |

## Table 5. CEO Equity Sales and Option Exercises Following Personal Income Tax Increases

This table shows the effects of personal income tax increases on CEO equity sales and options exercises. The stock and options are those of the firms where CEOs work in. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least 1% in a year and zero otherwise. Control variables are Assets, Mkt-Book, and 1+ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| VARIABLES | (1)<br>ΔLn($Shares Sold) | (2)<br>ΔLn($Options Exercised) |
|---|---|---|
| Tax Increase$_{t-1}$ | 0.398** | 0.255 |
| | [2.17] | [1.19] |
| Tax Increase$_{t-2}$ | 0.148 | -0.326 |
| | [0.34] | [-1.49] |
| ΔLn(Assets$_{t-1}$) | 1.646*** | 1.228*** |
| | [5.54] | [6.16] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.103*** | 0.059*** |
| | [4.27] | [4.14] |
| ΔLn(1+ROA$_{t-1}$) | 4.790*** | 3.130*** |
| | [9.76] | [8.37] |
| Observations | 36,709 | 36,709 |
| R-squared | 0.071 | 0.062 |
| CEO FE | Y | Y |
| Year FE | Y | Y |

## Table 6. CEO Delta and Personal Income Tax Changes

This table shows the effects of personal income tax increase on CEO delta. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases by at least 1% in a year and zero otherwise. Control variables are Assets, Mkt-Book, and 1+ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) |
|---|---|---|
| VARIABLES | ΔLn(delta) | ΔLn(delta) |
| | | |
| Tax Increase$_{t-1}$ | 0.035 | 0.038 |
| | [0.77] | [0.82] |
| Tax Increase$_{t-2}$ | 0.029** | 0.024** |
| | [2.27] | [2.08] |
| ΔLn(Assets$_{t-1}$) | 0.542*** | 0.450*** |
| | [19.46] | [12.81] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.140*** | 0.138*** |
| | [15.77] | [15.96] |
| ΔLn(1+ROA$_{t-1}$) | | 0.691*** |
| | | [5.81] |
| | | |
| Observations | 32,045 | 32,041 |
| R-squared | 0.340 | 0.354 |
| CEO FE | Y | Y |
| Year FE | Y | Y |

## Table 7. A Larger Pie to Share: Industry Profitability

This table shows the role of profitability in the effect of tax changes on CEO compensation. The sample is split into high-profit and low-profit groups based on the within-industry median of profit margin, where the profit margin of a firm is defined as (Sale – COGS)/Sale and industry is classified at the two-digit SIC level. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases by at least 1% in a year and zero otherwise. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) |
|---|---|---|
| VARIABLES | ΔLn(TDC1) | ΔLn(TDC1) |
| Group | High profit | Low profit |
| | | |
| Tax Increase$_{t-1}$ | -0.009 | 0.021 |
| | [-0.41] | [0.59] |
| Tax Increase$_{t-2}$ | 0.126*** | -0.010 |
| | [4.52] | [-0.28] |
| ΔLn(Assets$_t$) | 0.355*** | 0.271*** |
| | [8.21] | [8.55] |
| ΔMkt-Book$_t$ | 0.019*** | 0.009*** |
| | [3.36] | [4.78] |
| ΔROA$_t$ | 0.410*** | 0.704*** |
| | [4.14] | [6.00] |
| Observations | 16,259 | 19,873 |
| R-squared | 0.135 | 0.125 |
| p-value (coef equal) | 0.01 | |
| CEO FE | Y | Y |
| Year FE | Y | Y |

## Table 8. CEO Turnovers and CEO Pay Raises Following Personal Income Tax Increases

This table presents univariate and multivariate evidence on the relationship between CEO turnovers and CEO pay raises following personal income tax increases. Panel A shows the comparison of turnovers for CEOs receiving pay raises (Pay Raise) versus not receiving pay raises (No Pay Raise) following a large increase in personal income tax rates (more than 1%). The *p*-value is for the *t*-test of the equal means of a turnover dummy between the two groups. Panel B presents linear probability models of CEO turnover on a CEO pay raise dummy, *Pay Raise*, which is equal to one for CEOs who received a pay increase within two years of a personal income tax increase and zero otherwise. All CEOs in this subsample faced a large personal income tax increase in year *t-3*. Both specifications include firm and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Univariate Comparison

| | # Turnovers | % Turnovers | *p*-value |
|---|---|---|---|
| Pay Raise | 101 | 4.5% | 0.001 |
| No Pay Raise | 153 | 10.0% | |

Panel B: Regression Model

| | (1) | (2) |
|---|---|---|
| VARIABLES | CEO Turnover | CEO Turnover |
| Pay Raise$_{t-1}$ | -0.054** | -0.049** |
| | [-2.13] | [-2.02] |
| Log(Assets $_{t-1}$) | 0.003 | 0.010 |
| | [0.13] | [0.43] |
| Mkt-Book $_{t-1}$ | -0.007 | -0.005 |
| | [-1.41] | [-1.19] |
| Cash $_{t-1}$ | -0.042 | -0.033 |
| | [-0.48] | [-0.41] |
| Debt $_{t-1}$ | -0.098 | -0.084 |
| | [-1.00] | [-0.71] |
| R&D $_{t-1}$ | -0.108 | -0.096 |
| | [-0.48] | [-0.40] |
| Old CEO $_{t-1}$ | 0.086 | 0.108 |
| | [1.13] | [1.37] |
| ROA $_{t-1}$ | -0.269** | |
| | [-2.57] | |
| ROA $_{t-2}$ | 0.008 | |
| | [0.03] | |
| Return $_{t-1}$ | | -0.058** |
| | | [-2.15] |
| Return $_{t-2}$ | | -0.014 |
| | | [-0.43] |
| Observations | 1,099 | 1,108 |
| R-squared | 0.471 | 0.467 |
| Firm FE | Y | Y |
| Year FE | Y | Y |

## Table 9. Firm Performance and CEO Pay Raises Following Large Personal Income Tax Increases

This table presents univariate and multivariate evidence on the relationship between firm performance and CEO pay raises following personal tax increases. All CEOs in this subsample faced a large personal income tax increase in year *t*-3. We split the subsample based on whether the CEO received a pay increase. We measure firm performance in year *t*. Panel A presents univariate tests on firm performance split based on CEOs who received (or did not receive) a pay increase following a personal income tax rate increase (more than 1%). The *p*-value is for the *t*-test of the equal means of the performance measure between the two groups. Panel B presents multivariate tests of firm performance on a CEO pay raises. The CEO pay raise dummy, *Pay Raise*, is equal to one for CEOs who received a pay increase within two years of a personal income tax increase and zero for those who did not. All variables except the pay raise dummy are in first difference in both panels. All specifications include firm fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Univariate Comparison

| | ΔROA | ΔStock Return |
|---|---|---|
| Pay Raise$_{t-1}$ | 0.004 | 0.065 |
| No Pay Raise$_{t-1}$ | -0.010 | 0.005 |
| *p*-value | 0.001 | 0.001 |

Panel B: Multivariate Model

| | (1) | (2) |
|---|---|---|
| VARIABLES | ΔROA | ΔStock Return |
| Pay Raise$_{t-1}$ | 0.014** | 0.116*** |
| | [2.00] | [3.13] |
| Log(Assets $_{t-1}$) | 0.011 | -0.463*** |
| | [0.33] | [-3.76] |
| Mkt-Book $_{t-1}$ | 0.008* | 0 |
| | [1.88] | [0.15] |
| Cash $_{t-1}$ | 0.158*** | 0.738*** |
| | [2.93] | [3.19] |
| Debt $_{t-1}$ | 0.148*** | 0.827*** |
| | [2.80] | [4.14] |
| R&D $_{t-1}$ | 0.371 | -0.484 |
| | [1.55] | [-0.61] |
| ROA $_{t-1}$ | -0.434*** | |
| | [-3.52] | |
| ROA $_{t-2}$ | -0.207 | |
| | [-1.56] | |
| Return $_{t-1}$ | | -0.682*** |
| | | [-13.89] |
| Return $_{t-2}$ | | -0.232*** |
| | | [-4.35] |
| Observations | 943 | 920 |
| R-squared | 0.551 | 0.673 |
| Firm FE | Y | Y |
| Year FE | Y | Y |

## Table 10. Elasticity of CEO Compensation and Delta in the Net-of-Tax Rate

This table shows the elasticity of CEO compensation and CEO delta in the net-of-personal-income-tax rate. The dependent variable in Panel A (Panel B) is CEO total compensation (CEO delta), the control variables are Assets, Mkt-Book, and 1+ROA, , Δ denotes difference, Ln(.) is the natural logarithm, and $NOT_t$ is the after-tax multiple for pay $(1 - \tau_{m,f,t} - \tau_{m,s,t})$ for CEO *m* in year *t* (*f* (*s*) denotes federal (state)). As indicated by the second row, in Column 1 (2) the calculation of $NOT_t$ only considers large (small) tax changes greater (smaller) than 1%. Thus, in the tests for large (small) tax rate changes we set $NOT_{t-s}/NOT_{t-(s-1)} = 1$ for all CEO-year observations when the tax rate change is small (large). In Column 3 (4) we consider large tax rate increases and decreases and so set $NOT_{t-s}/NOT_{t-(s-1)} = 1$ for all CEO-year observations when the tax change is less than 1% and when the tax change is negative (positive). All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. The Appendix provides variable definitions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Estimates of the Elasticity of CEO Total Compensation in the Net-of-Tax Rate

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| VARIABLES | ΔLn(TDC1) | ΔLn(TDC1) | ΔLn(TDC1) | ΔLn(TDC1) |
| Tax Change | Large Tax Rate Change | Small Tax Rate Change | Large Increases Only | Large Decreases Only |
| Ln($NOT_{t-2}$/ $NOT_{t-1}$) | 0.478 | 0.805 | 0.559 | 0.070 |
| | [0.36] | [0.48] | [0.61] | [0.07] |
| Ln($NOT_{t-3}$/ $NOT_{t-2}$) | 1.251* | -1.192 | 1.987*** | -2.151 |
| | [1.86] | [-0.59] | [3.90] | [-1.41] |
| ΔLn($Assets_{t-1}$) | 0.340*** | 0.313*** | 0.313*** | 0.313*** |
| | [11.48] | [14.00] | [13.87] | [13.87] |
| ΔLn($Mkt\text{-}Book_{t-1}$) | 0.137*** | 0.169*** | 0.169*** | 0.169*** |
| | [10.91] | [17.94] | [17.98] | [17.98] |
| ΔLn(1+$ROA_{t-1}$) | 0.279*** | 0.383*** | 0.382*** | 0.383*** |
| | [4.06] | [5.39] | [5.40] | [5.42] |
| Constant | 0.034*** | 0.052*** | 0.029*** | 0.044*** |
| | [4.74] | [15.80] | [3.94] | [7.89] |
| Observations | 36,123 | 36,149 | 36,149 | 36,149 |
| R-squared | 0.124 | 0.131 | 0.132 | 0.132 |
| CEO FE | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y |

Panel B: Estimates of the Elasticity of CEO Delta in the Net-of-Tax Rate

| Sample | (1) ΔLn(delta) | (2) ΔLn(delta) | (3) ΔLn(delta) | (4) ΔLn(delta) |
|---|---|---|---|---|
| Tax Change | Large Tax Rate Change | Small Tax Rate Change | Large Increases Only | Large Decreases Only |
| Ln($NOT_{t-2}$/ $NOT_{t-1}$) | 0.663 | 1.696 | 1.261 | 1.059 |
| | [0.77] | [0.79] | [1.13] | [1.08] |
| Ln($NOT_{t-3}$/$NOT_{t-2}$) | 1.340* | 0.248 | 2.345** | 0.049 |
| | [1.83] | [0.08] | [2.61] | [0.04] |
| ΔLn($Assets_{t-1}$) | 0.564*** | 0.564*** | 0.596*** | 0.544*** |
| | [27.25] | [27.08] | [27.83] | [25.49] |
| ΔLn(Mkt-$Book_{t-1}$) | 0.766*** | 0.767*** | 0.805*** | 0.773*** |
| | [43.32] | [43.18] | [44.82] | [43.64] |
| Δ$Ln(1+ROA_{t-1})$ | 1.405*** | 1.405*** | 1.518*** | 0.855*** |
| | [13.24] | [13.29] | [11.80] | [10.67] |
| Constant | 0.043*** | 0.058*** | 0.021*** | 0.062*** |
| | [10.53] | [10.16] | [2.77] | [7.39] |
| Observations | 34,471 | 34,471 | 34,471 | 34,471 |
| R-squared | 0.489 | 0.489 | 0.447 | 0.489 |
| CEO FE | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y |

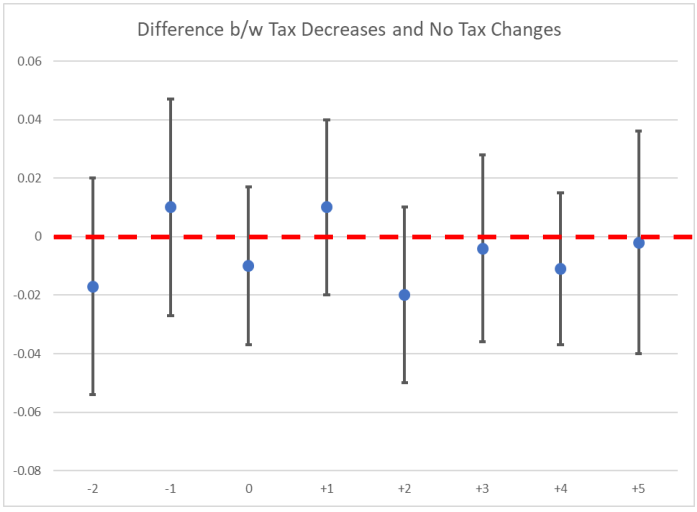
# Internet Appendix

## Figure IA1. Differences in CEO Pay Changes Between Treated and Control Groups in Years Around the Tax Changes: Extended Time Window

This figure shows the differences in CEO pay changes between the treated group and control group. The treated group includes CEOs in firms headquartered in states experiencing large personal income tax rate changes (greater than 1%). The control group includes CEOs in firms headquartered in states without personal income tax changes. Panel A (B) is for tax increases (decreases). The x-axis shows the year relative to an event year (as year 0). The y-axis shows the difference in CEO pay changes [Δln(TDC1), to be used as the dependent variable in DiD analysis]. The blue dots represent the average yearly differences in Δln(TDC1) between treated and control groups. The upper and lower bounds of the bars show the 90% confidence intervals. The red dashed line indicates the zero value of the y-axis.

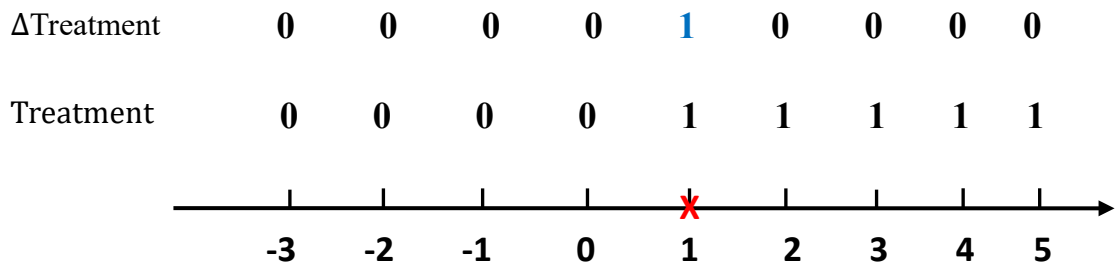
Panel A. Tax increases

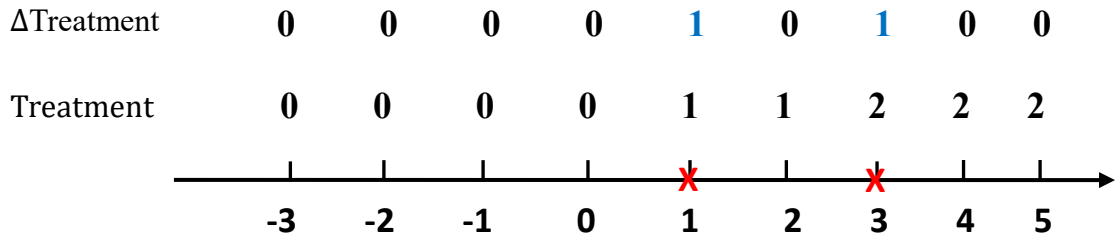

Panel B. Tax decreases



## Figure IA2. The First-difference Setting of the DiD Analysis

This figure illustrates the correspondence of the level of treatment dummy and the first difference in the treatment dummy. The upper (lower) panel shows the event study based on a single (two) event(s) as indicated by the red cross(es) on the time axis. *Treatment* is the treatment dummy (counter) variable that equals one (the number of treatments) after the corresponding shock(s). *Δ Treatment* is the first difference in Treatment and indicates an appearance of a new shock.



## Table IA1. CEO Compensation Responsiveness to Both State and Federal-Level Personal Income Tax Rate Changes

This table shows the effects of personal income tax rate changes on CEO total compensation, where personal income tax rate changes include changes at both the federal-level and state-level tax changes. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's personal income tax rate increases (decreases) by at least 1% in a year, and zero otherwise. All specifications include CEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variable definitions are in Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | ΔLn(TDC1) | ΔLn(TDC1) | ΔLn(TDC1) |
| | | | |
| Tax Increase$_{t-1}$ | 0.025 | | 0.027 |
| | [0.64] | | [0.73] |
| Tax Increase$_{t-2}$ | 0.081*** | | 0.084*** |
| | [4.94] | | [4.88] |
| Tax Decrease$_{t-1}$ | | 0.015 | 0.011 |
| | | [0.34] | [0.26] |
| Tax Decrease$_{t-2}$ | | 0.056 | 0.062 |
| | | [0.93] | [1.09] |
| ΔLn(Assets$_{t-1}$) | 0.324*** | 0.323*** | 0.324*** |
| | [11.20] | [11.12] | [11.05] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.013*** | 0.013*** | 0.013*** |
| | [5.51] | [5.50] | [5.51] |
| ΔLn(1+ROA$_{t-1}$) | 0.543*** | 0.544*** | 0.544*** |
| | [4.78] | [4.79] | [4.80] |
| | | | |
| Observations | 36,709 | 36,709 | 36,709 |
| R-squared | 0.116 | 0.116 | 0.116 |
| CEO FE | Y | Y | Y |
| Year FE | Y | Y | Y |

## Table IA2. NEO (Non-CEO) Compensation Responsiveness to Personal Income Tax Changes

This table shows the effects of changes in personal income tax rates on non-CEO NEO total compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if an NEO's state personal income tax rate increases (decreases) by at least 1% in a year and zero otherwise. Total pay is TDC1 in Execucomp database. The dependent variable is total CEO compensation, the control variables are Assets, Mkt-Book, and 1+ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include NEO fixed effects and year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

| VARIABLES | (1)<br>ΔLn(TDC1) | (2)<br>ΔLn(TDC1) | (3)<br>ΔLn(TDC1) |
|---|---|---|---|
| Tax Increase$_{t-1}$ | -0.017 | | -0.016 |
| | [-1.30] | | [-1.22] |
| Tax Increase$_{t-2}$ | 0.025 | | 0.025 |
| | [1.64] | | [1.47] |
| Tax Decrease$_{t-1}$ | | 0.024 | 0.020 |
| | | [1.17] | [0.92] |
| Tax Decrease$_{t-2}$ | | 0.003 | 0.003 |
| | | [0.09] | [0.07] |
| ΔLn(Assets$_{t-1}$) | 0.276*** | 0.266*** | 0.276*** |
| | [6.66] | [7.07] | [6.63] |
| ΔLn(Mkt-Book$_{t-1}$) | 0.009*** | 0.009*** | 0.009*** |
| | [5.54] | [5.56] | [5.54] |
| ΔLn(1+ROA$_{t-1}$) | 0.172** | 0.409*** | 0.172** |
| | [2.05] | [3.69] | [2.06] |
| Observations | 114,391 | 114,391 | 114,391 |
| R-squared | 0.134 | 0.136 | 0.134 |
| NEO FE | Y | Y | Y |
| Year FE | Y | Y | Y |